

Evaluating Mild Head Injuries

Incorporating the Standardized Assessment of Concussion

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Management of concussions in sports is one of the most controversial topics today, spanning all competition levels, from high school to professional. Estimates of the frequency of concussion are as high as 250,000 occurrences per year for all sports with 100,000 concussions occurring in football alone (2,3). Games significantly raise the risk of concussion. They are 11, 14, and 16 times more probable in football, girls soccer and boys soccer games, respectively (12). Among the controversies are poor consensus on a symptom related grading scale and the lack of evidence-based return to play options (1).

A concussion is a traumatically induced alteration in mental status not necessarily resulting in loss of consciousness (9,11). At present a complete understanding of the pathobiology of the brain injury from concussion is still lacking (13). There also is no treatment to aid in recovery from a concussion. The best management remains early recognition and prevention of additional concussion injury (6,13). The primary concern here is second impact syndrome, which may result in death. This unexplained phenomenon occurs when an athlete returns to play while still symptomatic from a concussion. The athlete then receives a second minor head trauma that results in rapid brain swelling.

The effects of concussions are easily overlooked and underestimated by athletes and medical professionals. A legitimate area of concern is the

cumulative effect of multiple concussions over months or years. Experiencing two or more concussions is associated with a reduction of cognitive skills (1). Repeated concussions also appear to result in increased severity and duration of baseline symptoms (1). Brain atrophy is associated with repeated concussions. They can lead to long-term impairment of cognitive processes, mood and behavior (1,13). After an initial concussion an athlete is four to six times more likely to experience another one (3,5). Research in this area is in its infancy and the long-term effects of multiple concussions in athletes warrants further study.

The cluster of residual symptoms that some individuals report after a concussion is another area of concern. The World Health Organization (14) has defined these symptoms as post concussion syndrome. While there is some debate to their cause and whether they actually represent a syndrome, their presence is remarkably consistent (4). A minority of individuals report symptoms beyond three and 12 months after a mild concussion (4,5).

The Mild Concussion

Mild concussions are estimated to account for more than 75 percent of all sports related brain injuries (9). Recently the concussion grading scale of the American Academy of Neurology (AAN) has received some consensus on use and it is shown in Table 1. Using this scale, a mild concussion may include a

grade one or grade two categorization (no loss of consciousness). The hallmark signs of a mild concussion include confusion, amnesia and headache.

Mild concussions are a significant challenge to medical professionals because they are the most difficult to detect (6). This is due to many factors. Athletes may present with a wide variety of transient symptoms (Table 2). There is no unconsciousness and other obvious signs may or may not be present. Signs and symptom may occur immediately or their appearance may be delayed (11). Post concussion symptoms are often quite subtle and can go unnoticed. Athletes will also often try to hide their symptoms in order to remain in competition (1,9).

The traditional head injury evaluation presents some limitations in identifying mild concussions. This evaluation focuses on neurological signs and symptoms (Table 2). This includes information reported by the athlete and observations made by the evaluator. Overall this evaluation lacks objectivity. There can be quite a bit of ambiguity as to what constitutes a failed balance test, for example. Athletes can also lie about their symptoms. Subtle cognitive deficits are not adequately addressed. Adding to the difficulty, it seems mental status abnormalities are more likely to occur than neurologic symptoms after mild concussions (9).

In 1997 the AAN suggested the development of a standardized evaluation tool that would assist medical personnel in recognizing concussions on the field. The AAN also emphasized the importance of assessing orientation, concentration and memory status in the concussion assessment.

Table 1

American Academy of Neurology Concussion Grading Scale
Grade 1
- Transient confusion
- No loss of consciousness
- Concussion symptoms or mental status abnormalities resolve in less than 15 minutes
Grade 2
- Transient confusion
- No loss of consciousness
- Concussion symptoms or mental status abnormalities last more than 15 minutes
Grade 3
- Any loss of consciousness

Neuropsychological Tests

While most athletes who sustain a mild concussion will recover completely, some athletes will experience chronic cognitive symptoms (13). Although data collection is early, neuropsychological tests are considered the most sensitive to identifying post concussion symptoms (6). The test is used after an athlete has been identified with a concussion to make return to play decisions. The neuropsychological evaluation is made up of a series of tests that measure an athlete's memory, attention/concentration, information processing and motor speed or coordination (6).

The Pittsburgh Steeler Test Battery is the most common form of testing and is being used for data collection in the NFL, NHL and major college football programs (6). The Pittsburgh Test Battery is an abbreviated version of a full evaluation and is considered a screening. The screening takes 20-30 minutes. Preseason baseline testing is required for accurate post injury interpretation (6,13). Normally the test is given within 24 hours after the

concussion and then repeated periodically over the next five to 10 days. Additional research with neuropsychological tests may better reveal the cumulative effects of concussion on functional performance (1). This may eventually lead to more effective evaluation strategies and return to play criteria.

Table 2

Signs and Symptoms of Head Injury
Neurological/Physical <ul style="list-style-type: none"> - Headache - Vision problems - Unequal pupil size - Pupillary response to light - Nystagmus (dancing eyes) - Poor visual tracking - Decreased peripheral vision - Tinnitus - Dizziness - Dazed Appearance - Retrograde Amnesia - Post-traumatic amnesia - Nausea/vomiting - Otorrhea (skull fx) - Rhinorrhea (skull fx) - Battles sign (skull fx) - Raccoon eyes (skull fx) - Slurred speech
Balance/Coordination Disturbance <ul style="list-style-type: none"> - Rhomberg test - Finger to nose (eyes open/closed) - Finger-nose-finger - Walk heel to toe - Walk straight line - Balance on one foot
Cognitive <u>Orientation</u> : deficits to person, place, time/date <u>Short term memory</u> : deficits in immediate or delayed recall <u>Concentration/Confusion</u> : inability to process instructions, perform mental tasks

Although promising, there are some major limitations of the neuropsychological screening on the college and high school level. Special training is required to administer the series of tests (6). A neuropsychologist is required to interpret the results and make return to play recommendations (1,6). Having a neuropsychologist on staff or even consulting is not a realistic financial possibility for high schools and most colleges. Finally, the length of time required for the baseline screening is prohibitive to including all athletes in a program. Finding an extra 30 minutes for each of 350 athletes is a major obstacle for the tester and the athlete. The widespread use of these tests will likely depend on the development of shorter screenings that can be scored and interpreted by typical athletic medical staff.

Standardized Assessment of Concussion

The Standardized Assessment of Concussion (SAC) was developed to establish a valid, standardized and systemic evaluation tool for the immediate assessment of concussion in athletes (7,13). The SAC was designed to test the domains of neuropsychological function that are most commonly affected by concussion (9, 13). It includes measures of orientation, immediate memory, concentration and delayed recall and is shown in Figure 1. According to neuropsychological research, these are the most common cognitive domains where deficits are noted following concussion (9,13).

The SAC provides a quantifiable assessment of the severity of head

trauma, which facilitates appropriate management of the athlete's injury and aids in assessing a player's readiness for return to competition (7). Medical professionals report it is difficult to assess the severity of injury in athletes because symptoms are often very subtle, or athletes tend to deny or down play their injuries. The objective and quantifiable nature of the SAC eliminates these problems, thus aiding in the prevention of more serious traumatic brain injury.

The administration of the SAC takes approximately five minutes and it can be scored by a non-neuropsychologist (13). Total score is computed in order to derive a composite index of the subject's overall level of impairment following concussion (Figure 1) (9). This tool is available in three alternate forms and comes in pocket-size for convenient side-line use (13). There are no meaningful differences between the three alternate forms of the SAC (9,13). This allows for the re-assessment of mental status following concussion while minimizing practice effects (9).

Data collected on the clinical validity of the SAC has supported the test's capability of detecting concussion and its use as a tool to determine an athlete's readiness to return to play (9). The SAC may be able to detect subtle cognitive changes associated with concussion in the absence of other symptoms (13). Two studies conducted in 1995 and 1996 revealed football players suspected of having a concussion scored significantly below their baseline score and below a group of normal, non-injured players on the SAC (9,13). The athlete's post-concussion scores dropped an average of 3.5 points from their pre-injury baseline scores (13) and dropped 3.7 points below the average score of the

controls (9). There is not yet enough data to support the use of the SAC without a baseline score, however (13).

There is no significant difference between scores observed during practice and actual games (3,9,13). This assures that 'game stress' does not affect test scores and baseline testing can provide a valid and reliable marker against which to detect change from an injury during games (3,9,13). Each component of the SAC can also be scored independently which allows the athletic trainer to identify subtle cognitive changes that may be present despite the absence of other symptoms.

The SAC is also free of ceiling effects (3,7,9). The average score for normal subjects was 1.60 standard deviations below the ceiling and only 7 percent of 182 subjects scored a perfect score of 30 (9,13). Age and education have minimal effects on SAC performance (9). Of particular clinical importance is the fact that athletic trainers participating in SAC studies have reported that the test is convenient for use on the sideline and it is easy to administer and score (9,13).

There are a few limitations regarding the SAC. There are several important symptoms not included in the test. These symptoms include headache, tinnitus, nausea and abnormalities related to the eyes and pupils. The SAC was not designed with the intention of replacing formal neurologic or neuropsychologic evaluation of the injured athlete. Rather it was designed to be used in combination with more formal evaluations to enhance the care of the brain injured athletes (9,13). Medical personnel must remember concussive symptoms may present differently across individuals and SAC scores may not indicate impairment, especially when

Figure 1: Standard Assessment of Concussion –SAC

Name: _____ Team: _____ Examiner: _____ Date of Exam: _____ Time: _____ Exam(Circle One): Bline Injury Post-Px/Game Day1 Day2 Day3 Day5 Day7 Day90		Neurologic Screening: Loss of Consciousness/ No Yes Witnessed Unresponsiveness Length: _____ Post-Traumatic Amnesia? No Yes Poor recall of events after injury Length: _____ Retrograde Amnesia? No Yes Poor recall of events before injury Length: _____																																													
Introduction: I am going to ask you some questions. Please listen carefully and give your best effort.		Strength Normal Abnormal Right Upper Extremity _____ Left Upper Extremity _____ Right Lower Extremity _____ Left Lower Extremity _____																																													
Orientation: What month is it? 0 1 What's the date today? 0 1 What's the day of the week? 0 1 What year is it? 0 1 What time is it right now? (within 1 hr) 0 1 Award 1 point for each correct answer. Orientation Total Score		Sensation- examples: Finger-to-Nose/ Rhomberg _____ Coordination- examples: Tandem walk _____ Finger-nose-finger _____																																													
Immediate Memory: I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order. <table border="1"> <thead> <tr> <th>List</th> <th>Trial 1</th> <th>Trial 2</th> <th>Trial 3</th> </tr> </thead> <tbody> <tr> <td>Elbow</td> <td>0 1</td> <td>0 1</td> <td>0 1</td> </tr> <tr> <td>Apple</td> <td>0 1</td> <td>0 1</td> <td>0 1</td> </tr> <tr> <td>Carpet</td> <td>0 1</td> <td>0 1</td> <td>0 1</td> </tr> <tr> <td>Saddle</td> <td>0 1</td> <td>0 1</td> <td>0 1</td> </tr> <tr> <td>Bubble</td> <td>0 1</td> <td>0 1</td> <td>0 1</td> </tr> <tr> <td>Total</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> Trials 2&3: I am going to repeat that list again. Repeat back as many words as you can remember in any order, even if I said the word before. Complete all 3 trials regardless of score on trial 1&2. Score 1pt. for each correct response. Total score equals sum across all 3 trials. Do not inform the subject that delayed recall will be tested.		List	Trial 1	Trial 2	Trial 3	Elbow	0 1	0 1	0 1	Apple	0 1	0 1	0 1	Carpet	0 1	0 1	0 1	Saddle	0 1	0 1	0 1	Bubble	0 1	0 1	0 1	Total				Concentration Digits Backward: I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7. If correct, go to next string length, if incorrect, read trial 2. Score 1 pt. for each string length. Stop after incorrect on both trials. <table border="1"> <tbody> <tr> <td>4-9-3</td> <td>6-2-9</td> <td>0</td> <td>1</td> </tr> <tr> <td>3-8-1-4</td> <td>3-2-7-9</td> <td>0</td> <td>1</td> </tr> <tr> <td>6-2-9-7-1</td> <td>1-5-2-8-6</td> <td>0</td> <td>1</td> </tr> <tr> <td>7-1-8-4-6-2</td> <td>5-3-9-1-4-8</td> <td>0</td> <td>1</td> </tr> </tbody> </table> Months in Reverse Order: Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll start with December, November...Go ahead. 1 pt. for entire sequence correct. Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan 0 1		4-9-3	6-2-9	0	1	3-8-1-4	3-2-7-9	0	1	6-2-9-7-1	1-5-2-8-6	0	1	7-1-8-4-6-2	5-3-9-1-4-8	0	1
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Immediate Memory Total Score		Concentration Total Score																																													
Exertional Maneuvers: If subject is not displaying or reporting symptoms, conduct the following maneuvers to create conditions under which symptoms are likely to be elicited and detected. These measures need not be conducted if a subject is already displaying or reporting any symptoms. If not conducted allow 2 minutes to keep time delay constant before testing Delayed Recall. These methods should be administered for baseline testing of normal subjects. 5 Jumping Jacks 5 Push-Ups 5 Sit ups 5 Knee Bends		Delayed Recall: Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order. Circle each word correctly recalled. Total score equals number of words recalled. Elbow Apple Carpet Saddle Bubble Delayed Recall Total Score																																													
		SAC Scoring Summary: Exertional Maneuvers & Neurologic Screening are important for examination, but are not incorporated into SAC Total Score. <table border="1"> <tbody> <tr> <td>Orientation</td> <td>/5</td> </tr> <tr> <td>Immediate Memory</td> <td>/15</td> </tr> <tr> <td>Concentration</td> <td>/5</td> </tr> <tr> <td>Delayed Recall</td> <td>/5</td> </tr> <tr> <td>SAC Total Score</td> <td>/30</td> </tr> </tbody> </table>		Orientation	/5	Immediate Memory	/15	Concentration	/5	Delayed Recall	/5	SAC Total Score	/30																																		
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neurologic symptoms are present. The SAC must be used in conjunction with a thorough neurologic evaluation on the sideline in order to determine the appropriate management of the injured athlete.

Additional research is also needed to determine the SAC's ultimate effectiveness. Although preliminary studies suggest the SAC is valid, more research is needed to confirm these findings. The research has only been conducted on young, male football players, which decreases the generalizability of the instrument. Future areas of research should be conducted utilizing this tool with females and other sports. Although it is difficult to assess, research is presently being conducted to determine the interrater reliability of the tool.

Return to Play

Once an athlete is suspected of a mild concussion, return to play decisions that day are crucial. The AAN's return to play guidelines are shown in Table 3. If an athlete continues to play with symptoms of concussion they risk additional brain injury and catastrophic outcomes. Therefore, no athlete should participate while symptomatic (2,3,5,11,13).

In order to return to play, any symptoms or mental status deficits must completely resolve within 15 minutes of the injury. This includes headache, which is often a discarded symptom when making these decisions. The athlete must be asymptomatic at rest and with exertional tests. Because some symptoms will appear in a delayed manner, periodic evaluations are required during the initial 15 minutes and as long as the athlete is symptomatic

(2,11,13). The objective is to monitor for deterioration in the athlete's condition, which warrants referral to the emergency room.

Table 3 AAN Concussion Return to Play Guidelines

Grade of Concussion	Return to play only after being asymptomatic with normal assessment at rest and with exercise
Grade 1 Concussion	15 minutes or less
Multiple Grade 1 Concussions	1 week
Grade 2 Concussions	1 week
Multiple Grade 2 Concussions	2 weeks
Grade 3- Brief Loss of Consciousness (seconds)	1 week
Grade 3- Prolonged Loss of Consciousness (minutes)	2 weeks
Multiple Grade 3 Concussions	1 month or longer, based on decision of evaluating physician.

If asymptomatic the athlete should then perform exertional tests (2,3). This allows the evaluation of the effects of the Valsalva maneuver under controlled conditions prior to return to play. This increases intracranial pressure and may cause the appearance of symptoms (2). These tests should include sit-ups, push-ups and agility drills.

In a game situation pressures are high for the athlete to return to competition. "Frequently the loss of objectivity on the part of athlete, coaches, sports media and spectators is an unfortunate and potentially harmful bias. In that setting, the health professional's role is to provide objective assessment of the injured athlete and guidance about the

advisability of a safe return to competition (3).” If the athlete is cleared to return to play, periodic re-evaluations are indicated to monitor for a return of symptoms or mental status abnormalities.

If symptoms last longer than 15 minutes the athlete can not return to play that day. This is an important determination. It advances the athlete into a grade two classification and will result in removal from participation for at least one week. The resolution of their symptoms within this initial 15-minute period has a huge swing in the athlete’s return to play time frame.

This athlete then requires periodic re-evaluations that day and in the days that follow. These evaluations monitor for worsening symptoms (requiring referral) and also determine the first day the athlete is symptom free. An athlete with symptoms that last longer than one week warrants referral and possible imaging studies (11). A key point to remember is, return to play is one week after being asymptomatic not one week from the injury date. All athletes with a grade two classification should receive final clearance for participation from the team physician.

Although the return to play guidelines provide important structure, there are several gray areas. For example, the athlete whose symptoms resolve in 18 or 25 minutes present difficult decision making. Or, the athlete who is symptom free at game time, but the next day, during follow-up, reveals she developed a headache that evening and now is asymptomatic again. There are hundreds of scenarios such as these that require careful and individual decision making.

It also is not known whether neurocognitive function returns to

normal when the athlete’s symptoms subside (13). This indicates it can not be assumed an athlete has returned to pre-injury status as soon as their symptoms clear. This is the primary reason an athlete is to remain out of competition for a period of time after they are symptom free. While there are several concussion guidelines and numerous gray areas there is consensus on one point: no athlete should participate who still has neurologic or cognitive symptoms (2,11,13).

Figure 2 Post Concussion Symptom Questionnaire

Name: _____ Date: _____					
Sport: _____					
Instructions: We would like to know if you now suffer any of the symptoms given below. As many of these symptoms may occur normally, we would like you to compare yourself now with before the injury. Please select a number based on the following: 0 = Not experiencing at all 1 = No more of a problem than usual 2 = A mild problem 3 = A moderate problem 4 = A severe problem					
Compared with before the injury, do you now (over the last 24 hours) suffer from:					
Headaches	0	1	2	3	4
Feelings of dizziness	0	1	2	3	4
Noise sensitivity	0	1	2	3	4
Sleep disturbances	0	1	2	3	4
Fatigue, tiring more easily	0	1	2	3	4
Being irritable, easily angered	0	1	2	3	4
Feeling depressed or tearful	0	1	2	3	4
Feeling frustrated or impatient	0	1	2	3	4
Forgetfulness, poor memory	0	1	2	3	4
Poor Concentration	0	1	2	3	4
Taking longer to think	0	1	2	3	4
Blurred vision	0	1	2	3	4
Light sensitivity (upset by bright light)	0	1	2	3	4
Double vision	0	1	2	3	4
Restlessness	0	1	2	3	4
Are you experiencing any other difficulties?					
Please specify and rate as above:					
1. _____	0	1	2	3	4
2. _____	0	1	2	3	4
Total:					

Our Approach

At Stockton College our concussion management focuses on three principles. The first is to identify potential neurosurgical emergencies such as hemorrhaging. The next is to prevent catastrophic injury associated with brain swelling. The final issue is to avoid cumulative injury secondary to repeated trauma (3). With these things in mind we use the AAN guidelines and have developed the following protocol for managing mild concussions. It includes continuous efforts to educate the athletes and coaches about the potential dangers of mild head injury.

- During physicals all athletes with a history of concussion are given a baseline SAC. A list of all baseline SAC scores, organized by sport, are kept in each medical kit.
- Any athlete suspected of a mild concussion is given a SAC as the initial part of the evaluation.

We use the SAC score as an initial disqualifier from participation only. This means if the athlete misses their cutoff score they are held from further competition. However, if they meet their cutoff score they must then pass a traditional neurologic evaluation before they can return to play.

- In practice situations, athletes with a baseline score must at least equal this value. During games baseline athletes must score within two points of their pretest score to advance to the

neurologic criteria for return to play.

- In practice and game situations, athletes without a baseline test must score at least 25 on their SAC to advance to the neurologic criteria for return to play.

There is not yet enough data to validate the use of SAC scores without a baseline test (13). However, we feel it is reasonable to use the SAC score as a disqualifying criteria, particularly since 85 percent of uninjured athletes score 25 or above (8). We believe this is more effective than relying solely on a neurologic evaluation.

- All athletes assessed with a mild concussion begin follow-up evaluations that day. The next day the athlete begins follow-up for post concussion symptoms with a SAC, neurologic evaluation and a Post Concussion Symptom Questionnaire. This continues until all symptoms resolve at rest and with exercise.

We recently implemented the Rivermead Post Concussion Symptoms Questionnaire, shown in Figure 2. The questionnaire is reliable in identifying the severity of post concussion symptoms (4). Another advantage is it allows the athlete to compare their post concussion symptoms with their pre-injury status. This is useful because some individuals may experience

these problems unrelated to a concussion (4).

- When an athlete becomes asymptomatic at rest we begin exertional tests the next day. These will increase in intensity and duration daily (as long as the athlete is asymptomatic) until they return to play.
- All athletes assessed with a grade two concussion receive final clearance for competition from our team physician.

Conclusion

The identification and management of mild concussions in athletics presents the health care professional with many difficulties. The development of objective criteria such as the Pittsburgh Steeler Test Battery, the Standardized Assessment of Concussion Questionnaire is movement in the correct direction. Additional research with these tools and further enhancements will provide valuable advancements in mild concussion management. Although there are numerous concussion grading scales and management guidelines, they all agree on one main principle. No athlete should participate in his or her sport while symptomatic.

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